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Research on Sine Dynamic Torque Measuring System

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Abstract

Researches on dynamic torque measuring system centering on computers are always hot spots of the researches on dynamic torque measuring system in the process of mechanics measurement. This paper, by analyzing and discussing the design of dynamic torque measurement system, gives a complete design scheme for dynamic torque measurement and, by combining with those key technical problems existing therein, provides certain technological base for further study on the measurement of dynamic torque after analyzing and discussing what can affect dynamic torque measuring system.

Keywords: dynamic torque; mechanics measurement; measuring system

1. Introduction

At the present time when computer technology and sensor technology have developed rapidly, the measurement of continuously dynamic parameters is applied widely in many aspects such as aviation, aerospace, ship, weapons, petroleum, electron, etc. Furthermore, in the process of measurement and testing, multichannel rapidly-changed analog signals are needed to be collected and preprocessed at the same time. The dynamic torque measuring system based on strain torque sensor and data acquisition system has become one of the most potential areas as well as more active than some in the field of torque measurement.

At present, professional measurement and testing for torque are mainly conducted via data fed back by sensors. After intermediate changer and recording instrument have finished dynamic test for objects, mechanics behavior characteristics of the objects under test are analyzed according to signals collected by

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torque sensor. This thesis focuses on the study of designing dynamic data measuring system and, with dynamic measuring system of mechanics measurement as application background, completes measuring mechanics measurement data from the perspective of collecting data and designing sensor in order to provide technological base for study on dynamic calibration in the process of mechanics measurement.

2. The Lectotype and Design of Dynamic Torque Data Acquisition System

2.1. The Design of Hardware Structure

This data acquisition system are mainly composed of analog part, digit part and interface part, whose structure chart is illustrated as follows, of which the analog part mainly contains analog intermediate-frequency signal preprocessing module and analog-to-digital conversion module; the rest parts of the digit part are completely designed in FPGA except clock generator; the interface part contains PCI Bus interface and parallel interface.

This system is designed like this: First, the adjusted analog signals are input into A/D converter via analog intermediate-frequency signal preprocessing module. Then, 16 bit digital signals are output into FPGA after analog-to-digital conversion. High speed buffer DCFIFO, high-speed memory DPRAM as well as a series of sequential control logic are designed in FPGA so that data sent from ADC can be stored in pre-fixed capacity in real time. At the same time, there are two kinds of data transmission interface designed in FPGA so that the system can transmit data by parallel interface or by PCI Bus interface under the module we have chosen[1].

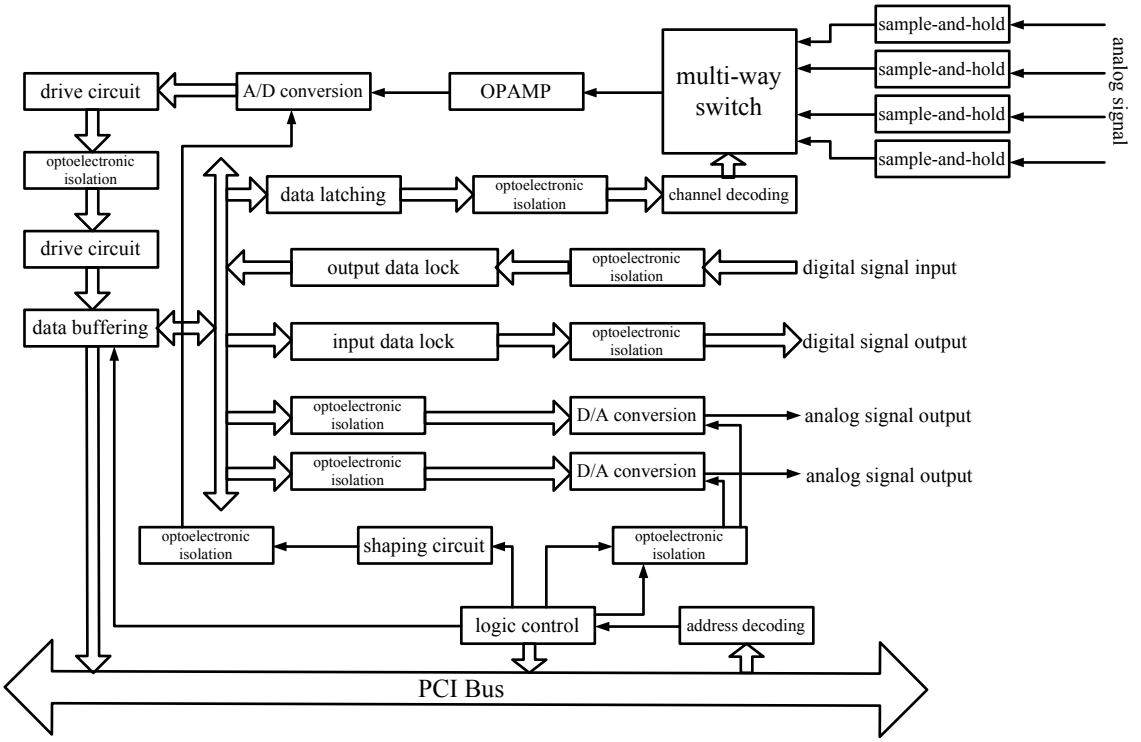

Fig. 1. The Structure Chart of Dynamic Data Acquisition System

2.2. Software Control Design

1) Control Logic Analysis

As the core of the dynamic torque data acquisition system, control logic circuit is mainly responsible for choosing gain multiple, controlling ADC acquisition, counting and generating sequential address of dual-port memory, arbitrating Local Bus, generating chip signals of each chip and all kinds of sequential control, etc.

After being input and entering into acquisition card, signals, first, are pre-amplified by signal amplifier under the control of logic control. In the same way, under the control of logic control, A/D changer takes samples from amplified signals, sampled objects being stored into dual-port buffer in the form of binary system. After each sampling, addresses of dual-port buffer will add one automatically via control logic, so sampled data are stored by linear way in buffer area over time. When one buffer area is filled with sampled data, control logic will send an interruption request to Local Bus. Since signals in Local Bus are mapped to PCI Bus while passing through PCI interface circuit (vice versa), the computer will receive an interruption request before starting a transmission. With the cooperation of control logic, data in dual-port buffer area are read into Local Bus by time schedule controller and mapped to PCI Bus via PCI interface, and thereby these data are read into computer memory. It is thus clear that the whole data amplification, data acquisition, data buffer and data transmission are conducted orderly under the control of control logic[2].

2) Control Flow Design

The data acquisition flow are designed as the following Fig. 2:

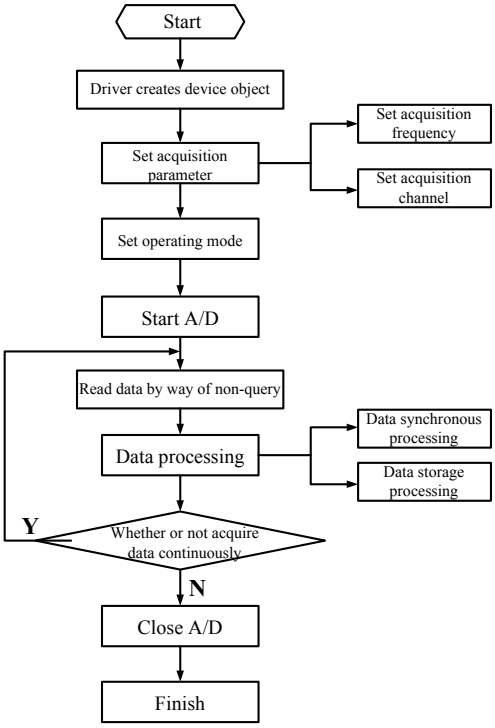

Fig. 2. Control Flow Chart of Dynamic Data Acquisition

3. The Application of Dynamic Torque Measuring System

The above dynamic data acquisition system and strain torque sensor form dynamic torque measuring system. The main technical indexes are illustrated as Table 1. The actual measured data of an American MTS electro-hydraulic servo torsional fatigue tester in the process of factory acceptance is illustrated in Table 2. Data tested through the dynamic torque measuring system reflects basically this tester's metering performance has reached up to the prospective technical indexes, which means this tester has been accepted.

Table 1. The Main Technical Indexes of Torque Sensor

Range of Torque Sensor	(30～1500)Nm
Nature frequency	Greater than 1000Hz
Accuracy grade	Grade 0.1
Calibration basis	JJG 391-2009 Force sensor

Table 2. Application of Measuring system in the process of testing data

Range of application of dynamic torque	(50～1000)Nm
Range of test frequency	（1～30）Hz
Source of the System	Torque standard machine
Testing basis	Referring to JJG556-1988 axial loading fatigue tester
Test result	Clockwise moment and inverse moment (static) Error of indication and repeatability of indication≤1%
	Clockwise moment and inverse moment (dynamic) Error of indication and repeatability of indication≤3%

4. Key Technology and Problem Analysis

4.1. The Synchronization of Data Interface among Asynchronous Clock Domains

With synchronous design, the system can promote its 's correctness, stability and durability. Moreover, such system has little burr and metastable state and is easy to be analyzed in timing sequence. Asynchronous design, though endowing the system with burr and metastable state which can be restrained and removed through some man-made interface, has simple structure and can save resources. In some occasions, the asynchronous design can reduce the turnover times of flip-flop within the system so that power dissipation will be reduced. But its timing sequence performance is not so stable as synchronous design and is more complicated to be analyzed. Therefore, in the process of FPGA design, asynchronous design should be avoided and synchronous design should be adopted as much as possible to improve the system's operational quality[3].

4.2. Problems Existing in the Application of Dynamic Torque Measuring System

1) The Problem about Correcting Moment of Inertia of Dynamic Torque

With increasing frequency, the dynamic torque's error of indication increases continually, which means corresponding correction for moment of inertia is necessary. Since angular speed, acceleration or

other parameters are difficult to be determined or the measurement error is too big, it is necessary that modifier formula should be further determined.

2) The Source of Dynamic Torque

For the lack of corresponding continuously dynamic torque datum, the measurement of many dynamic torque still rests on test phase on the basis of theoretical analysis, short of experimental verification.

5. Conclusion

With the development of society and the science progress, the fields we are setting foot in become wider and wider, which puts forward new requests for measurement and testing technology. Dynamic torque measurement is attracting people's more and more attention. Torque measurement has only been confined to static torque measurement for quite a long time. Along with the development of high-precision testers at modern times, approaches to measuring dynamic torque is improving day by day and accuracy is raising constantly. The contradiction between the frequency of continuously dynamic torque data acquisition and its accuracy is the key of the whole torque measurement acquisition system. Furthermore, with the further development of electronic component's integrated technology, software technology as well as sensor technology, we will go deep into the researches on continuously dynamic torque calibration system, so multiple-parameter dynamic calibration technology will be applied into wider fields.

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